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(54) **TAPERED THREADED BOLT BODY AND TAPERED THREADED NUT**

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F16B 35/04 (2006.01)
F16B 39/282 (2006.01)

(52) **U.S. Cl.**

CPC ***F16B 33/02*** (2013.01); ***F16B 35/041*** (2013.01); *F16B 39/282* (2013.01)

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CPC F16B 25/0078; F16B 33/00; F16B 33/02; F16B 35/041; F16B 39/00; F16B 39/282; F16B 39/36
USPC 411/265, 411, 424, 426, 436
See application file for complete search history.

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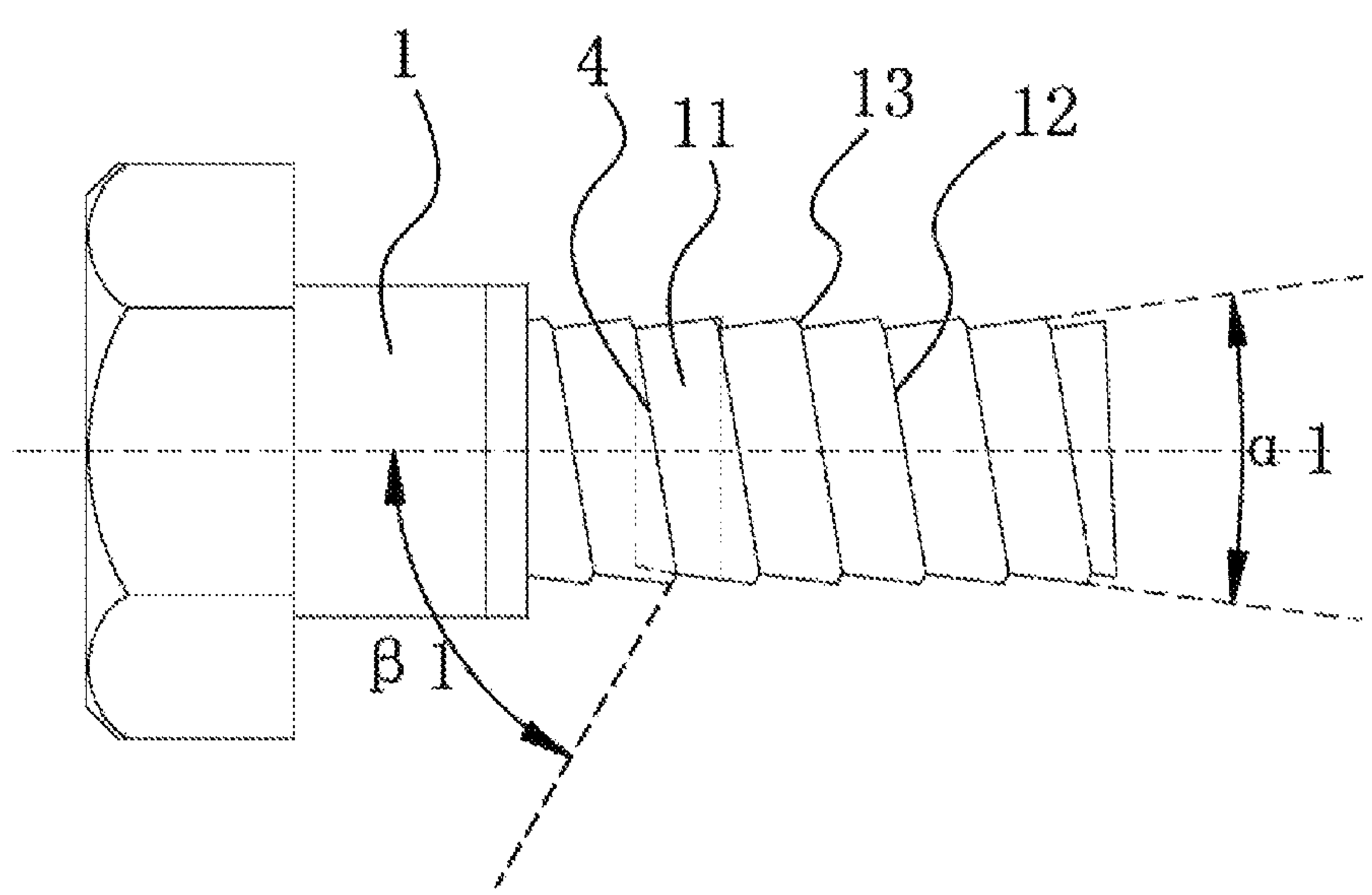
(57) **ABSTRACT**

A tapered threaded bolt and nut are provided. The bolt comprises a main body; an outside helical surface and a first end helical surface are defined on the main body; a shape of the outside helical surface is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the main body, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the main body; a shape of the first end helical surface is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution. An inside helical surface and a second end helical surface are defined in a screw hole of the nut.

12 Claims, 6 Drawing Sheets



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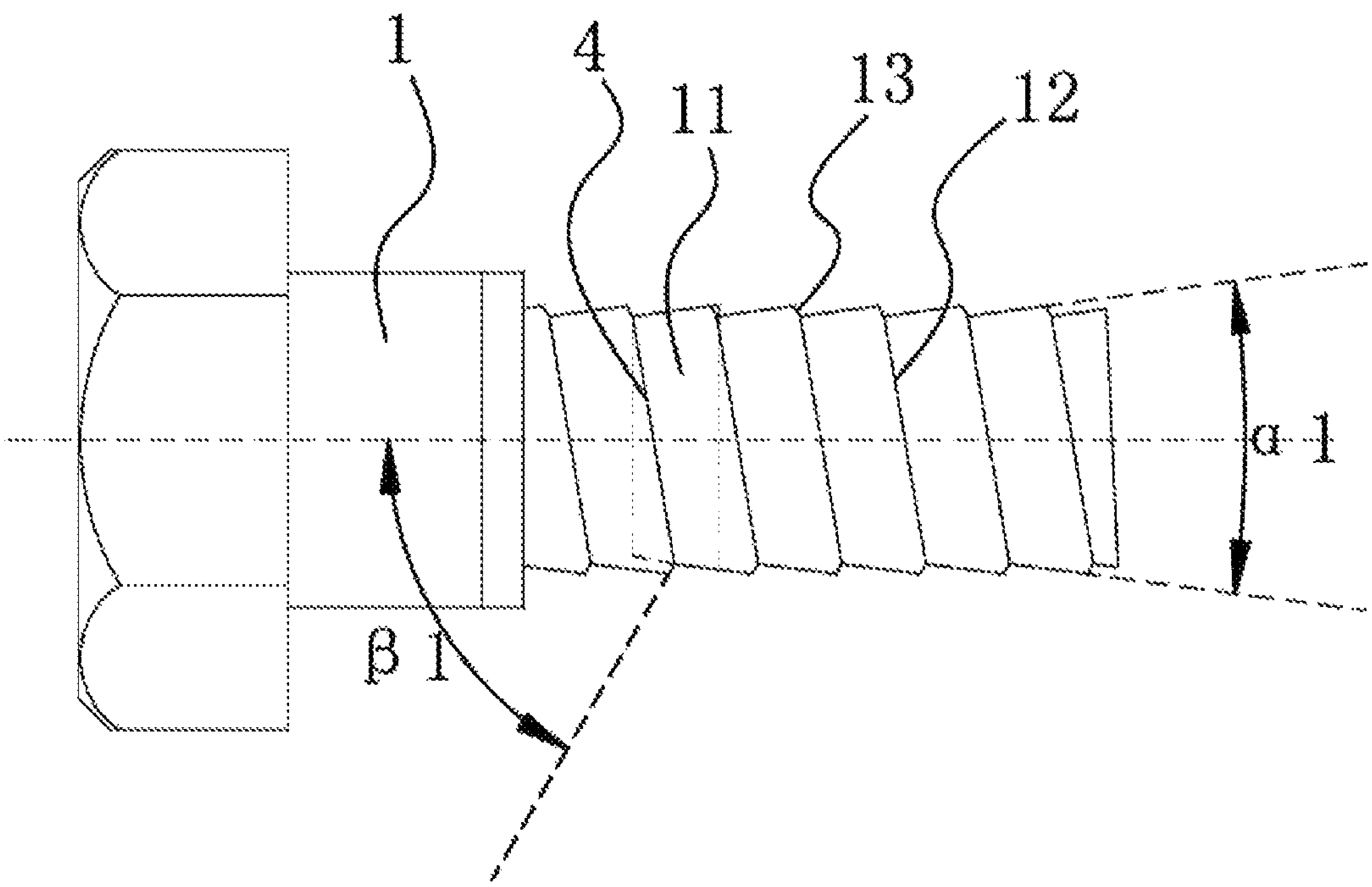

FIG.1

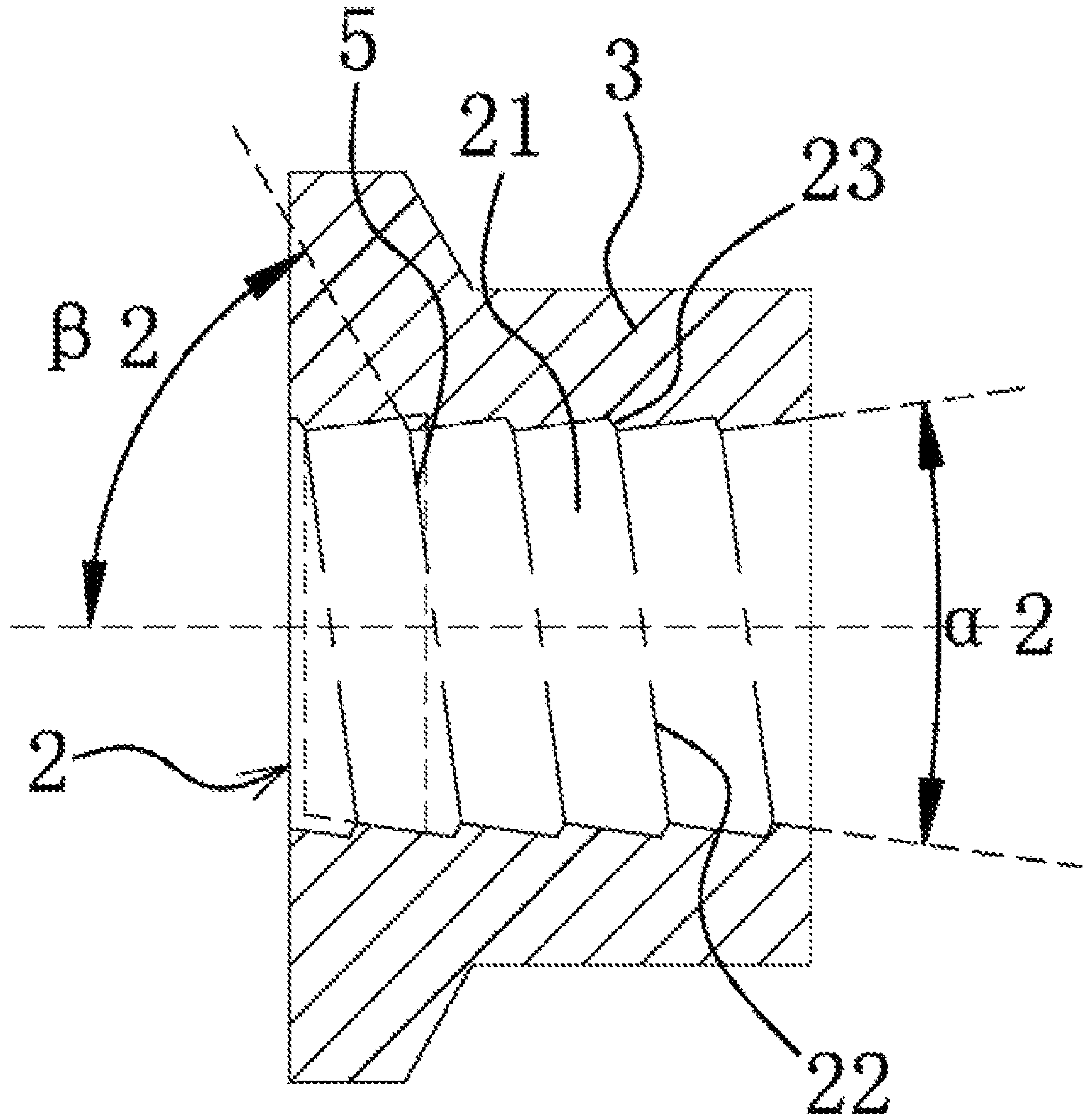

FIG. 2

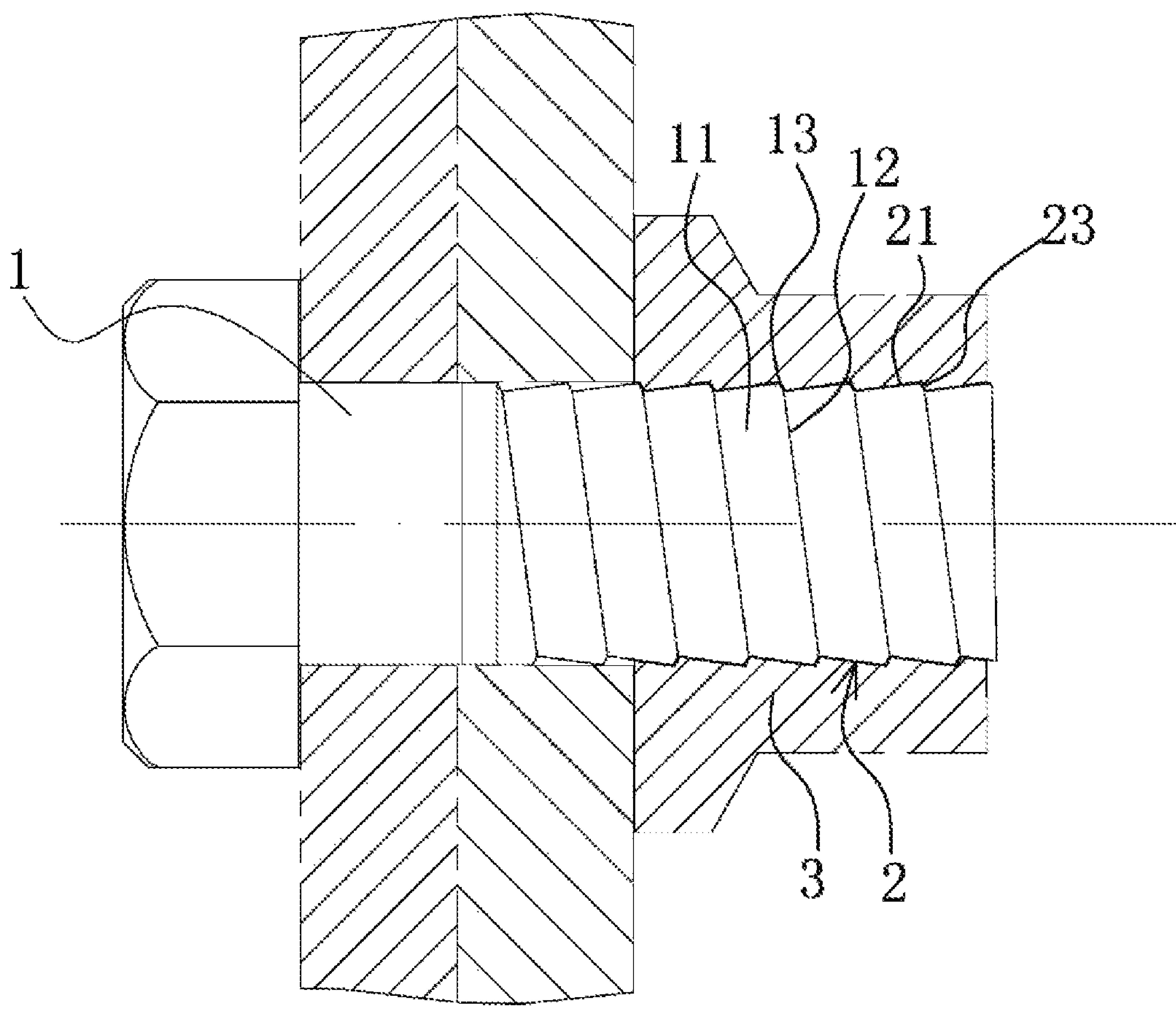

FIG.3

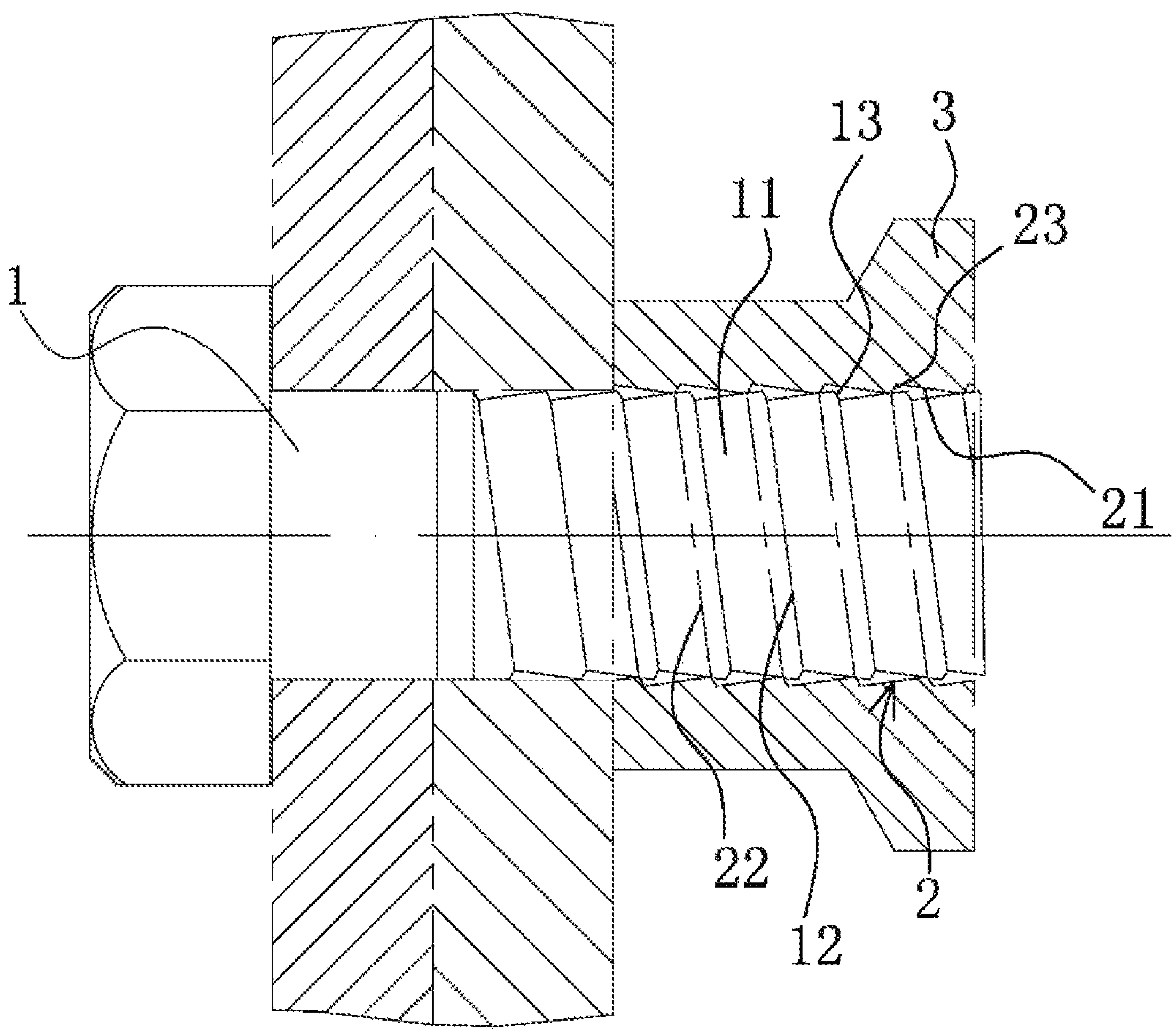

FIG.4

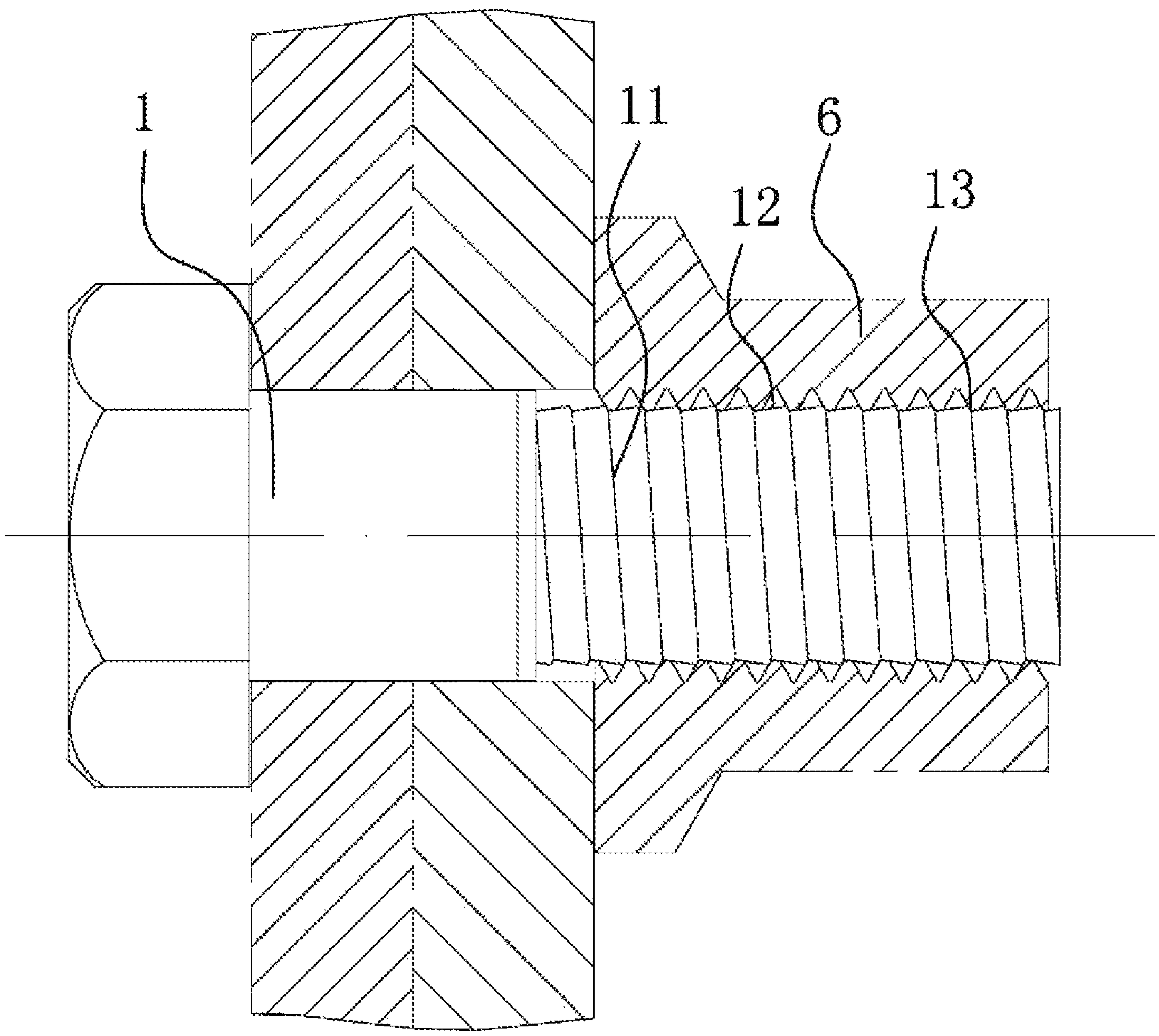

FIG.5

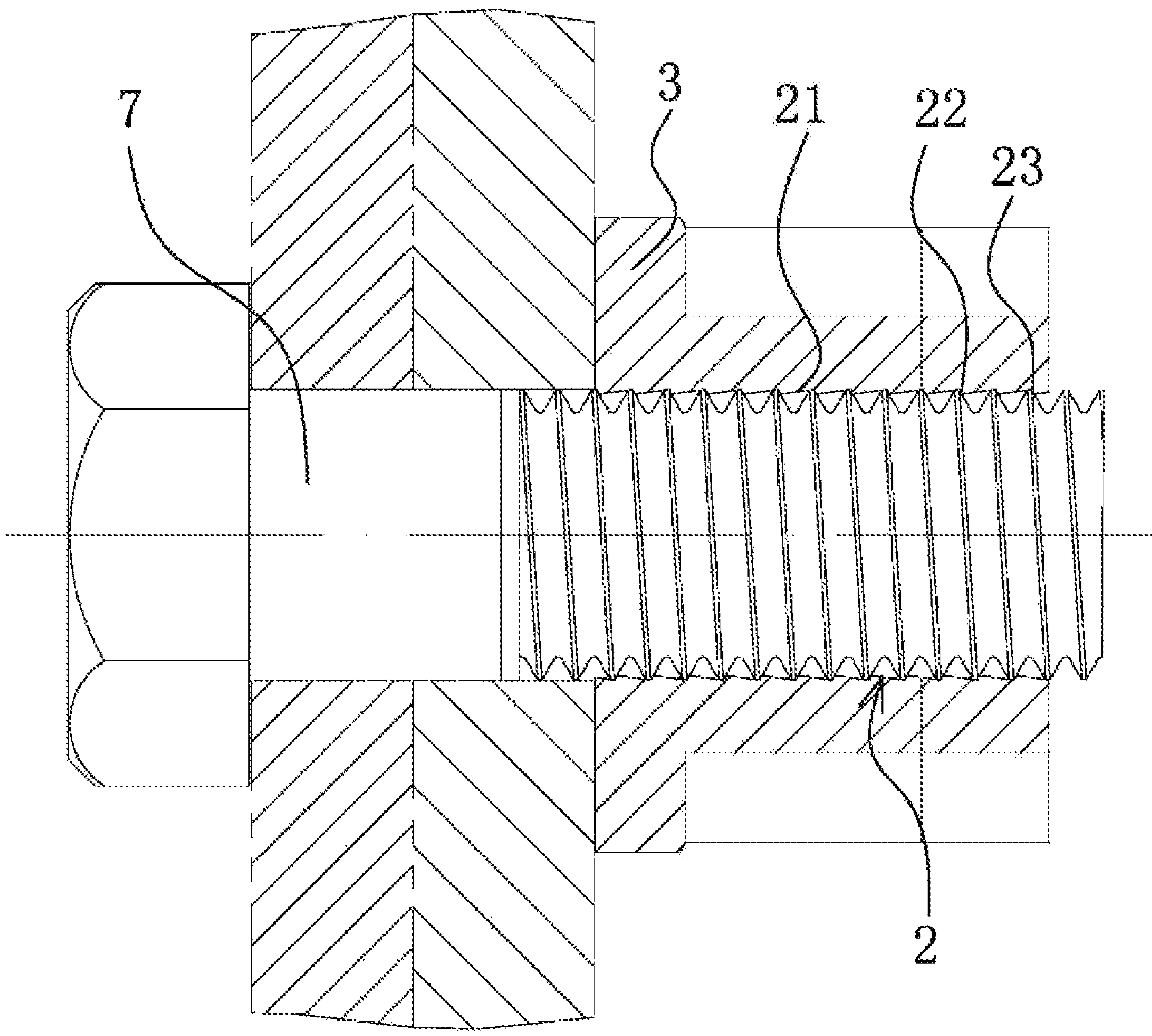

FIG.6

TAPERED THREADED BOLT BODY AND TAPERED THREADED NUT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of International Patent Application No. PCT/CN2016/107050 with a filing date of Nov. 24, 2016, designating the United States, now pending, and further claims priority to Chinese Patent Application No. 201510821335.4 with a filing date of Nov. 24, 2015. The content of the aforementioned applications, including any intervening amendments thereto, are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to the field of thread connection structure, and more particularly to a tapered threaded bolt and a tapered threaded nut.

BACKGROUND OF THE PRESENT INVENTION

A screw thread is a ridge wrapped around a cylinder or cone in the form of a helix. A screw thread is one of the first standardized mechanical structure elements, which has been widely used in all kinds of fields. The screw thread can be divided into many species and types with the one defined on a cylinder being called a straight thread, the one defined on a cone being called a tapered thread, and the one defined on an end surface of a cylinder or a truncated cone being called a plane thread. The screw thread defined on an outer circular surface of a main body is called an external thread, the screw thread defined on an inner circular surface of a main body is called an internal thread, and the screw thread defined on an end surface of a main body is called an end thread. The screw thread with its rotation direction and helix orientation following the left hand grip rule is called a left-handed thread, and the screw thread with its rotation direction and helix orientation following the right hand grip rule is called a right-handed thread. The screw thread with a single helix on a cross section of a main body is called a single-start thread, the screw thread with double helixes is called a double-start thread, and the screw thread with multiple helixes is called a multi-start thread. The screw thread with a triangular cross section is called a triangular thread, the screw thread with a trapezoidal cross section is called a trapezoidal thread, the screw thread with a rectangular cross section is called a rectangular thread, and the screw thread with a zigzagging cross section is called a zigzagging thread. The screw thread used for fastening connection is called a fastening connection thread, the screw thread mainly used for transmission is called a transmission connection thread, and the screw thread used for conduit connection is called a conduit connection thread.

The screw thread of a fastener is the fastening connection thread, which is usually a cylinder thread with a triangle cross section, and is usually a right-handed thread while a left-handed thread is used for special use. The screw thread of a fastener is usually a single-start thread while a double-start or multi-start thread is used for celerity disassembly and assembly. The screw thread of a fastener comprises a screw thread pair, i.e. an internal thread and an external thread. The coupling nature of the screw thread pair is determining by the requirements of the connection system. The basic requirements of the fastener on the screw thread are loading-bearing and self-locking capability instead of transmission capability. The basic condition for self-locking thread is that an equivalent friction angle is no less than a lead angle. The value of an equivalent friction angle is related to a thread angle, the bigger the thread angle is, the bigger the equivalent friction angle is, and the more beneficial to self-locking that is the fundamental cause of the thread angle of fastener being 60° C. The wedge thread proposed in recent years, also called "Spiralock nut", is an improvement to both of the metric screw threads and English screw threads, aiming at improving the self-locking capability of the screw thread defined on a fastener. The metric screw threads include ISO metric threads (M screw threads), aerospace metric threads (MJ screw threads), small metric threads (S screw threads) and Russian screw threads (MR screw threads), etc. the English screw threads include unified screw threads (UN screw threads), aerospace inch threads (UNJ screw threads). Whitworth threads and so on. In the English screw threads, the thread angle is 60° C. except that of the Whitworth thread.

The key factor for unthreading problem of the threaded fastener is the structure of the screw thread. In this case, the American engineers re-designed the geometric shape of the screw thread after researching on the shape the screw and force loaded on the fastener. At the end of 1970s, the technology of screw thread called "Spiralock" was proposed. The structure of "Spiralock" thread is that a wedge surface with a 30° C. inclination is defined at the root of a negative thread (internal triangular thread, i.e. female thread). When the bolt is coupled with the nut, a teeth portion of the external thread of a standard bolt abuts against the wedge incline of the internal thread, and hence generating interference screw locking to increase locking force. The increase of the locking force is due to the change of the thread angle which hence makes the angle between the normal force between the internal and external threads and an axis of the bolt to be 60° C. instead of 30° C., i.e. the angle of a standard thread. Obviously, the normal force of "Spiralock" thread is significantly greater than fasten stress. Thus, the locking friction generated is greatly increased. The technical level and professional direction are always focused on thread angles in researching on and solving the unthreading problem of threaded fasteners. The wedge threads are no exception. Moreover, the wedge threads are only partial variation of triangle threads. There is no wedge thread pair in use, and the wedge thread can be only used as female which couples with an external triangle thread. The locking force of the wedge thread is determined by the thread angle, and the loading force and self-locking capability of the wedge thread is the same as those of conventional thread techniques. The bolt or nut in the prior art has the defect of being easy unthreaded. With frequent shock of the device, the gap between the connection elements is increased, and the bolt and nut are hence unthreaded, or even fell out. In this case, it is easy for connectors in mechanical connection to depart from each other, or even cause security incident.

Aiming at the defects in the prior art, there has been a long-term exploration, and kinds of solutions have been proposed. For example, Chinese patent No. 201410521899.1 discloses a lock nut with changed thread pattern which comprises a nut body with an internal thread, a spiraling-up conic surface is defined on crest of the internal thread. As a preferred embodiment, an angle between a generatrix of the conic surface and center axis of the internal thread is 30° C. As a preferred embodiment, two ends of the nut body are an entrance and an exit of the bolt respectively. The entrance of the bolt extends outwardly to form a step, an inclination of a step surface of the step is S, an edge of the exit of the bolt is an inclined surface with an inclination of D. As an improvement of above preferred embodiment, the S is ranged from 20° C. to 30° C., and the D is 30° C.

Above solution an improvement to a certain extent in solving the problem of easy looseness of connection between the bolt and nut in prior art. However, there are still the problems of low bonding strength, low self-locking capability and low loading capability in above solution.

SUMMARY OF PRESENT INVENTION

Aiming at above technical problems, an object of the disclosure is to provide a bolt with a tapered thread with professional design, simple structure, good connection performance, high self-locking capability. The key point of the disclosure is the structure of external thread of the bolt.

Aiming at above technical problems, another object of the disclosure is to provide a nut with a tapered thread with reasonable design, simple structure, good connection performance, high self-locking capability. The key point of the disclosure is the structure of internal thread of the nut.

In order to achieve above objects, technical solutions of the present disclosure are as follows:

A bolt with a tapered thread comprises a main body; an outside helical surface and a first end helical surface are defined on the main body; a shape of the outside helical surface is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the main body, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the main body; a shape of the first end helical surface is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution; the tapered thread of the bolt for each rotation is in a geometrical shape of a helical external cone; the outside helical surface is a helical external conical surface of the helical external cone; the first end helical surface is a helical end surface of the helical external cone; a first cone angle ($\alpha 1$) is formed between outside helical surfaces.

The bolt with the tapered thread is matched with a standard nut with a metric thread in use, such as a triangular internal thread, wedge internal thread, rectangular internal thread, trapezoidal internal thread, and zigzagging internal thread, etc. Alternatively, the bolt with the tapered thread is matched with a novel tapered threaded nut with an inside helical surface matching with the outside helical surface of the bolt in use. The technical performances such as connecting performance, self-locking capability, anti-loosening property, loading capability, sealing property and so on are achieved by sizing between the outside helical surface and inside helical surface or metric thread until interference fit, namely the outside helical surface and inside helical surface or metric thread are centralized under the guiding of the helix until they are in interference contact with each other. It should be noted that the matching between the internal and external cones is the matching between the outside and inside conical surfaces in fact. In other words, when the internal and external cones match with each other, the matching surfaces between them are conical surfaces. In order to realize self-locking, the internal and external cones must satisfy some requirements which are relative to the conical surface and conical degree (cone angle) of the cone and are irrelevant to the end surface of the cone. However, it does not mean that a cone with any conical degree can be self-locked. In order words, it does not mean a cone with any cone angle can be self-locked. When the internal and external cones match with each, they can be self-locked only when the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces are in a certain rang. Therefore, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are irrelevant to the external helix guiding angle and internal helix guiding angle and are relative to the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces. In other words, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are mainly determined by the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces, and are also relative to friction factors of the bolt and nut to some extent.

In above bolt with the tapered thread, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid. This structure ensures the outside helical surface is enough in length, and enough strength is ensured when the outside helical surface matches with the metric thread or inside helical surface.

In above bolt with the tapered thread, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to the length of the cathetus of the right trapezoid. This structure ensures the outside helical surface is enough in length, and enough strength is ensured when the outside helical surface matches with the metric thread or inside helical surface.

In above bolt with the tapered thread, both the outside helical surface and the first end helical surface are continuous helical surfaces or non-continuous helical surfaces. Preferably, both the outside helical surface and the first end helical surface are continuous helical surfaces.

In above bolt with the tapered thread, a first transitional guiding surface is arranged between the outside helical surface and the first end helical surface on a same rotation. The first transitional guiding surface, as a helical end surface of the external cone, is designed based on the first end helical surface and is a variation of the first end helical surface to facilitate the matching between the internal and external threads and to be used as a design and manufacture rule. The first transitional guiding surface facilitates the manufacture of the outside helical surface and the first end helical surface, protects the internal and external threads from interference when they matching with each other and makes the matching more effective. A helical external thread line is formed between two adjacent outside helical surfaces. A vertical distance between the highest point and the lowest point of the external thread line, i.e. a height of the external helix guiding angle, is much less than a height of thread angle of the screw thread in prior art. Such comparison is based on the prerequisite that the pitch of the external thread in the present disclosure is the same as that of the external thread in prior art. The practical meaning is that the semi-cone angle of the first cone angle of the external helical surface is less than thread bottom angle of the tooth-type thread. The height of the thread angle refers to thread height or thread depth of tooth-type thread, i.e. metric internal thread. An external helix guide angle ($\beta 1$) is defined as an angle between an inclined surface form by a highest point and a lowest point of the external thread line and an axis of the tapered thread. The screw thread is with a more compact structure, higher strength, higher loading capability and better mechanical sealing performance, and a physical space for manufacturing the tapered external thread is larger.

A nut with a tapered thread comprises a tubular body with a screw hole; an inside helical surface and a second end helical surface are defined in the screw hole; a shape of the inside helical surface is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the screw hole, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the screw hole; a shape of the second end helical surface is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution; the tapered thread of the nut for each rotation is in a geometrical shape of a helical internal cone; the inside helical surface is a helical internal conical surface of the helical internal cone; the second end helical surface is a helical end surface of the helical internal cone; a second cone angle is formed between inside helical surfaces.

The nut with the tapered thread is matched with a standard bolt with a metric thread in use, such as a triangular external thread, wedge external thread, rectangular external thread, trapezoidal external thread, and zigzagging external thread, etc. Alternatively, the nut with the tapered thread is matched with a novel tapered threaded bolt with an outside helical surface matching with the inside helical surface of the nut in use. The technical performances such as connecting performance, self-locking capability, anti-loosening property, loading capability, sealing property and so on are achieved by sizing between the outside helical surface and inside helical surface or metric thread until interference fit, namely the outside helical surface and inside helical surface or metric thread are centralized under the guiding of the helix until they are in interference contact with each other. It should be noted that the matching between the internal and external cones is the matching between the outside and inside conical surfaces in fact. In other words, when the internal and external cones match with each other, the matching surfaces between them are conical surfaces. In order to realize self-locking, the internal and external cones must satisfy some requirements which are relative to the conical surface and conical degree (cone angle) of the cone and are irrelevant to the end surface of the cone. However, it does not mean that a cone with any conical degree can be self-locked. In order words, it does not mean a cone with any cone angle can be self-locked. When the internal and external cones match with each, they can be self-locked only when the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces are in a certain rang. Therefore, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are irrelevant to the external helix guiding angle and internal helix guiding angle and are relative to the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces. In other words, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are mainly determined by the first cone angle of the outside helical surfaces and the second cone angle of the inside helical surfaces, and are also relative to friction factors of the bolt and nut to some extent.

In above nut with the tapered thread, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid. This structure ensures the inside helical surface is enough in length, and enough strength is ensured when the outside helical surface matches with the metric thread or inside helical surface.

In above nut with the tapered thread, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to the length of the cathetus of the right trapezoid. This structure ensures the outside helical surface is enough in length, and enough strength is ensured when the outside helical surface matches with the metric thread or inside helical surface.

In above nut with the tapered thread, both the inside helical surface and the second end helical surface are continuous helical surfaces or non-continuous helical surfaces. Preferably, both the inside helical surface and the second end helical surface are continuous helical surfaces.

In above nut with the tapered thread, a second transitional guiding surface is arranged between the inside helical surface and the second end helical surface on a same rotation. The second transitional guiding surface, as a helical end surface of the internal cone, is designed based on the second end helical surface and is a variation of the second end helical surface to facilitate the matching between the internal and external threads and to be used as a design and manufacture rule. The second transitional guiding surface facilitates the manufacture of the inside helical surface and the second end helical surface, protects the internal and external threads from interference when they matching with each other and makes the matching more effective. A helical internal thread line is formed between two adjacent inside helical surfaces. A vertical distance between the highest point and the lowest point of the internal thread line, i.e. a height of the internal helix guiding angle, is much less than a height of thread angle of the screw thread in prior art. Such comparison is based on the prerequisite that the pitch of the internal thread in the present disclosure is the same as that of the internal thread in prior art. The practical meaning is that the semi-cone angle of the second cone angle of the internal helical surface is less than thread bottom angle of the tooth-type thread. The height of the thread angle refers to thread height or thread depth of tooth-type thread, i.e. metric internal thread. An internal helix guide angle (β**2**) is defined as an angle between an inclined surface form by a highest point and a lowest point of the internal thread line and an axis of the tapered thread. The screw thread is with a more compact structure, higher strength, higher loading capability and better mechanical sealing performance, and a physical space for manufacturing the tapered external thread is larger.

Compared with prior art, the bolt and nut with the tapered thread in this disclosure have the following advantageous of professional design, simple structure, easy operation, high locking force, high loading capability, good anti-loosening property, good mechanical sealing property, good stability and high self-locking capability. The fastening and connection functions can be realized by sizing between the internal and external cones until they are coupling with interference fit. The bolt and nut are capable of avoiding unthreading.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of a bolt with a tapered thread according to the present invention;

FIG. **2** is a schematic exploded view of a nut with a tapered thread according to the present invention;

FIG. **3** is a schematic diagram showing the bolt with the tapered thread and the nut with the tapered thread when a spiral direction of an outside helical surface of the bolt and a spiral direction of an inside helical surface of the nut are the same as each other;

FIG. **4** is a schematic diagram showing the bolt with the tapered thread and the nut with the tapered thread coupled with each other when a spiral direction of an outside helical surface of the bolt and a spiral direction of an inside helical surface of the nut are opposite to each other;

FIG. **5** is a schematic diagram showing the bolt with the tapered thread and a metric nut coupled with each other; and

FIG. **6** is a schematic diagram showing the nut with the tapered thread and a metric bolt coupled with each other.

In the drawings, **1**—main body; **11**—outside helical surface; **12**—first end helical surface; **13**—first transitional guiding surface; **2**—screw hole; **21**—inside helical surface; **22**—second end helical surface; **23**—second transitional guiding surface; **3**—tubular body; **4**—external thread line; **5**—internal thread line; **6**—metric nut (standard nut); **7**—metric bolt (standard bolt); α**1**—first cone angle; α**2**—second cone angle; β**1**—external helix guiding angle; and β**2**—internal helix guiding angle.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is further described below in combination with drawings and embodiments.

As shown in FIG. **1**, a bolt with a tapered thread comprises a main body **1**. An outside helical surface **11** and a first end helical surface **12** are defined on the main body **1**. A shape of the outside helical surface **11** is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the main body **1**, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the main body **1**. A shape of the first end helical surface **12** is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution. The tapered thread of the bolt for each rotation is in a geometrical shape of a helical external cone. The outside helical surface **11** is a helical external conical surface of the helical external cone. The first end helical surface **12** is a helical end surface of the helical external cone. A first cone angle α**1** is formed between outside helical surfaces **11**. As shown in FIG. **5**, the bolt with the tapered thread is matched with a standard nut (metric nut) **6** with a metric thread in use, such as a triangular internal thread, wedge internal thread, rectangular internal thread, trapezoidal internal thread, and zigzagging internal thread, etc. Alternatively, as shown in FIG. **3** and FIG. **4**, the bolt with the tapered thread is matched with a novel tapered threaded nut with an inside helical surface **21** matching with the outside helical surface **11** of the bolt in use. A direction of a big end of the internal cone with the inside helical surface **21** and a direction of a big end of the external cone with the outside helical surface **11** are capable of being the same as or different to each other. The technical performances such as connecting performance, self-locking capability, anti-loosening property, loading capability, sealing property and so on are achieved by sizing between the outside helical surface **11** and inside helical surface **21** or metric thread until interference fit, namely the outside helical surface **11** and inside helical surface **21** or metric thread are centralized under the guiding of the helix until they are in interference contact with each other. It should be noted that the matching between the internal and external cones is the matching between the outside and inside conical surfaces in fact. In other words, when the internal and external cones match with each other, the matching surfaces between them are conical surfaces. In order to realize self-locking, the internal and external cones must satisfy some requirements which are relative to the conical surface and conical degree (cone angle) of the cone and are irrelevant to the end surface of the cone. However, it does not mean that a cone with any conical degree can be self-locked. In order words, it does not mean a cone with any cone angle can be self-locked. When the internal and external cones match with each, they can be self-locked only when the first cone angle α**1** of the outside helical surfaces **11** and the second cone angle α**2** of the inside helical surfaces **21** are in a certain rang. Therefore, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are irrelevant to the external helix guiding angle β**1** and internal helix guiding angle β**2** and are relative to the first cone angle β**1** of the outside helical surfaces **11** and the second cone angle α**2** of the inside helical surfaces **21**. In other words, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are mainly determined by the first cone angle α**1** of the outside helical surfaces **11** and the second cone angle α**2** of the inside helical surfaces **21**, and are also relative to friction factors of the main body **1** and nut **6** to some extent.

As shown in FIG. **1**, specifically, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid. This structure ensures the outside helical surface **11** is enough in length, and enough strength is ensured when the outside helical surface **11** matches with the metric thread or inside helical surface **21**. Both the outside helical surface **11** and the first end helical surface **12** are continuous helical surfaces or non-continuous helical surfaces. Preferably, both the outside helical surface **11** and the first end helical surface **12** are continuous helical surfaces.

Further, a first transitional guiding surface **13** is arranged between the outside helical surface **11** and the first end helical surface **12** on a same rotation. The first transitional guiding surface **13**, as a helical end surface of the external cone, is designed based on the first end helical surface **12** and is a variation of the first end helical surface **12** to facilitate the matching between the internal and external threads and to be used as a design and manufacture rule. The first transitional guiding surface **13** facilitates the manufacture of the outside helical surface **11** and the first end helical surface **12**, protects the internal and external threads from interference when they matching with each other and makes the matching more effective. A helical external thread line is formed between two adjacent outside helical surfaces. A helical external thread line **4** is formed between two adjacent outside helical surfaces **11**. A vertical distance between the highest point and the lowest point of the external thread line **4**, i.e. a height of the external helix guiding angle β**1**, is much less than a height of thread angle of the screw thread in prior art. Such comparison is based on the prerequisite that the pitch of the external thread in the present disclosure is the same as that of the external thread in prior art. The practical meaning is that the semi-cone angle of the first cone angle α**1** of the external helical surface **11** is less than thread bottom angle of the tooth-type thread. The height of the thread angle refers to thread height or thread depth of tooth-type thread, i.e. metric internal thread. An external helix guide angle β**1** is defined as an angle between an inclined surface form by a highest point and a lowest point of the external thread line **4**. i.e. the first transitional guiding surface **13**, and an axis of the tapered thread. The screw thread is with a more compact structure, higher strength, higher loading capability and better mechanical sealing performance, and a physical space for manufacturing the tapered external thread is larger.

As shown in FIG. **2**, a nut with a tapered thread comprises a tubular body **3** with a screw hole **2**. An inside helical surface **21** and a second end helical surface **22** are defined in the screw hole **2**. A shape of the inside helical surface **21** is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the screw hole **2**, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the screw hole **2**. A shape of the second end helical surface **22** is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution. The tapered thread of the nut for each rotation is in a geometrical shape of a helical internal cone. The inside helical surface **21** is a helical internal conical surface of the helical internal cone. The second end helical surface **22** is a helical end surface of the helical internal cone. A second cone angle $\alpha 2$ is formed between inside helical surfaces **21**. As shown in FIG. **7**, the nut with the tapered thread is matched with a standard bolt (metric bolt) **7** with a metric thread in use, such as a triangular external thread, wedge external thread, rectangular external thread, trapezoidal external thread, and zigzagging external thread, etc. Alternatively, as shown in FIG. **3** and FIG. **4**, the nut with the tapered thread is matched with a novel tapered threaded bolt with the outside helical surface **11** matching with the inside helical surface **21** of the nut in use. The technical performances such as connecting performance, self-locking capability, anti-loosening property, loading capability, sealing property and so on are achieved by sizing between the outside helical surface **11** and the inside helical surface **21** or metric thread until interference fit, namely the outside helical surface **11** and the inside helical surface **21** or metric thread are centralized under the guiding of the helix until they are in interference contact with each other. It should be noted that the matching between the internal and external cones is the matching between the outside and inside conical surfaces in fact. In other words, when the internal and external cones match with each other, the matching surfaces between them are conical surfaces. In order to realize self-locking, the internal and external cones must satisfy some requirements which are relative to the conical surface and conical degree (cone angle) of the cone and are irrelevant to the end surface of the cone. However, it does not mean that a cone with any conical degree can be self-locked. In order words, it does not mean a cone with any cone angle can be self-locked. When the internal and external cones match with each, they can be self-locked only when the first cone angle $\alpha 1$ of the outside helical surfaces **11** and the second cone angle $\alpha 2$ of the inside helical surfaces **21** are in a certain rang. Therefore, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are irrelevant to the external helix guiding angle $\beta 1$ and internal helix guiding angle $\beta 2$ and are relative to the first cone angle $\alpha 1$ of the outside helical surfaces **11** and the second cone angle $\alpha 2$ of the inside helical surfaces **21**. In other words, the technical performances such as the loading capability, self-locking capability, anti-loosening performance, sealing performance and so on are mainly determined by the first cone angle $\alpha 1$ of the outside helical surfaces **11** and the second cone angle $\alpha 2$ of the inside helical surfaces **21**, and are also relative to friction factors of the bolt and nut to some extent.

As shown in FIG. **2**, when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid. This structure ensures the inside helical surface **21** is enough in length, and enough strength is ensured when the outside helical surface **11** matches with the metric thread or inside helical surface **21**. Both the inside helical surface **21** and the second end helical surface **22** are continuous helical surfaces or non-continuous helical surfaces. Preferably, both the inside helical surface **21** and the second end helical surface **22** are continuous helical surfaces.

Further, a second transitional guiding surface **23** is arranged between the inside helical surface **21** and the second end helical surface **22** on a same rotation. The second transitional guiding surface **23**, as a helical end surface of the internal cone, is designed based on the second end helical surface **22** and is a variation of the second end helical surface **22** to facilitate the matching between the internal and external threads and to be used as a design and manufacture rule. The second transitional guiding surface **23** facilitates the manufacture of the inside helical surface **21** and the second end helical surface **22**, protects the internal and external threads from interference when they matching with each other and makes the matching more effective. A helical internal thread line **5** is formed between two adjacent inside helical surfaces. A vertical distance between the highest point and the lowest point of the internal thread line **5**, i.e. a height of the internal helix guiding angle $\beta 2$, is much less than a height of thread angle of the screw thread in prior art. Such comparison is based on the prerequisite that the pitch of the internal thread in the present disclosure is the same as that of the internal thread in prior art. The practical meaning is that the semi-cone angle of the second cone angle $\alpha 2$ of the internal helical surface **21** is less than thread bottom angle of the tooth-type thread. The height of the thread angle refers to thread height or thread depth of tooth-type thread, i.e. metric internal thread. An internal helix guide angle $\beta 2$ is defined as an angle between an inclined surface form by a highest point and a lowest point of the internal thread line **5**, i.e. the second transitional guiding surface **23**, and an axis of the tapered thread. The screw thread is with a more compact structure, higher strength, higher loading capability and better mechanical sealing performance, and a physical space for manufacturing the tapered external thread is larger.

The specific embodiments described in this disclosure are exemplary illustrations to the spirit of the present invention. It is obvious to one of ordinary skill in the art to make modifications and/or supplementary and/or obtain equivalence using a similar principle under the teaching of this disclosure without departing from the spirit of the present invention or being beyond the protection scope defined in the claims.

Understandably, although the structure of the screw thread are implemented on bolt and nut as disclosed in this disclosure, it is obvious to one of ordinary skill in the art that the structure of the screw thread can be implemented on other products, such as valves with threaded structure, transmission mechanisms, containers and so on, as long as the products have internal and external threads coupling with each other.

Although terms such as main body **1**, outside helical surface **11**, first end helical surface **12**, first transitional guiding surface **13**, screw hole **2**, inside helical surface **21**, second end helical surface **22**, second transitional guiding surface **23**, tubular body **3**, external thread line **4**, internal thread line **5**, metric nut (standard nut) **6**, metric bolt (standard bolt) **7**, first cone angle α**1**, second cone angle α**2**, external helix guiding angle β**1**, and internal helix guiding angle **12** and so on, have been widely used in the present disclosure, other terms can also be used alternatively. These terms are only used to better description and illustration the essence of the present invention. It departs from the spirit of the present invention to deem it as any limitation of the present invention.

I claim:

1. A bolt with a tapered thread, comprising a main body wherein an outside helical surface and a first end helical surface are defined on the main body; a shape of the outside helical surface is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the main body, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the main body; a shape of the first end helical surface is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution; a first cone angle (α**1**) is formed between outside helical surfaces; the tapered thread of the bolt is in a geometrical shape of a helical external cone; the outside helical surface is a helical external conical surface of the helical external cone; the first end helical surface is a helical end surface of the helical external cone; a helical external thread line is formed between two adjacent outside helical surfaces; an external helix guide angle (β**1**) is defined as an angle between an inclined surface form by a highest point and a lowest point of the external thread line and an axis of the tapered thread, a vertical distance between the highest and lowest points of the external thread line is defined as a height of the external helix guide angle (β**1**); the bolt with the tapered thread is capable of matching with a nut with a tapered thread or a standard nut; the outside helical surface and an inside helical surface or a standard internal thread of the standard nut are cooperated for sizing until they are in interference fit with each other; the outside helical surface and an inside helical surface or a standard internal thread of the standard nut are centralized under the guiding of the helix until they are in interference contact with each other; self-locking capability, leak-tightness, loading capability of a thread connection pair is determined by values of the first cone angle (α**1**) of the outside helical surfaces and a second cone angle (α**2**) of inside helical surfaces; and fastening and connecting functions are realized by sizing of internal and external cones until interference fitting.

2. The bolt according to claim **1**, wherein when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid.

3. The bolt according to claim **2**, wherein when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to the length of the cathetus of the right trapezoid.

4. The bolt according to claim **1**, wherein both the outside helical surface and the first end helical surface are continuous helical surfaces or non-continuous helical surfaces.

5. The bolt according to claim **1**, wherein a first transitional guiding surface is arranged between the outside helical surface and the first end helical surface on a same rotation.

6. The bolt according to claim **1**, wherein a direction of a big end of the internal cone with the inside helical surface and a direction of a big end of the external cone with the outside helical surface are capable of being the same as or different to each other.

7. A nut with a tapered thread, comprising a tubular body with a screw hole wherein an inside helical surface and a second end helical surface are defined in the screw hole; a shape of the inside helical surface is the same as a shape of a lateral surface of a solid of revolution formed by using a right trapezoid as a generatrix, rotating uniformly around a cathetus of the right trapezoid which is coincident with a center axis of the screw hole, and synchronously, axially and uniformly moving the right trapezoid along the center axis of the screw hole; a shape of the second end helical surface is the same as a shape of helical end surface with a same direction as an axial moving direction of the solid of revolution; a second cone angle (α**2**) is formed between inside helical surfaces; the tapered thread of the nut is in a geometrical shape of a helical internal cone; the inside helical surface is a helical internal conical surface of the helical internal cone; the second end helical surface is a helical end surface of the helical internal cone; a helical internal thread line is formed between two adjacent inside helical surfaces; an internal helix guide angle (β**2**) is defined as an angle between an inclined surface form by a highest point and a lowest point of the internal thread line and an axis of the tapered thread, a vertical distance between the highest and lowest points of the internal thread line is defined as a height of the internal helix guide angle (β**2**); the nut with the tapered thread is capable of matching with a bolt with a tapered thread or a standard bolt; the inside helical surface and an outside helical surface or a standard external thread of the standard nut are cooperated for sizing until they are in interference fit with each other; the inside helical surface and an outside helical surface or a standard external thread of the standard nut are centralized under the guiding of the helix until they are in interference contact with each other; self-locking capability, leak-tightness, loading capability of a thread connection pair is determined by values of a first cone angle (α**1**) of outside helical surfaces and the second cone angle (α**2**) of the inside helical surfaces; and fastening and connecting functions are realized by sizing of internal and external cones until interference fitting.

8. The bolt according to claim **7**, wherein when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to or greater than a length of the cathetus of the right trapezoid.

9. The bolt according to claim **8**, wherein when the right trapezoid goes through one rotation, a distance that the right trapezoid axially moves is equal to the length of the cathetus of the right trapezoid.

10. The bolt according to claim **7**, wherein both the inside helical surface and the second end helical surface are continuous helical surfaces or non-continuous helical surfaces.

11. The bolt according to claim **7**, wherein a second transitional guiding surface is arranged between the inside helical surface and the second end helical surface on a same rotation.

12. The bolt according to claim **7**, wherein a direction of a big end of the internal cone with the inside helical surface and a direction of a big end of the external cone with the outside helical surface are capable of being the same as or different to each other.

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